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1 TITLE OF THE INVENTION

2 AUTOMOBILE TRANSMISSION

3 BACKGROUND OF THE INVENTION

4 1. Field of the invention

5 The present invention relates to a transmission for  
6 a vehicle and more particularly to an automobile transmission  
7 which can be assembled using components shared among a plurality  
8 of transmission types.

9 2. Discussion of prior arts

10 A transmission for transmitting engine power to  
11 driving wheel and for changing engine rotational speeds, is  
12 connected with a crankshaft of an engine through a clutch and  
13 has a main shaft and a counter shaft provided in parallel with  
14 the main shaft. The main shaft is provided with a plurality of  
15 driving gears and the counter shaft is provided with a plurality  
16 of driven gears meshing with the driving gears. When a driver  
17 operates a shift lever, a power transmission path obtained by  
18 a gear set of a driving gear and driven gear is established.

19 There is no difference in the basic construction  
20 between a transmission for front wheel drive vehicle and one for  
21 four wheel drive vehicle.

22 In case where the engine is mounted in the longitudinal  
23 direction of the vehicle, since the transmission is connected  
24 with the rear end of the engine, a power unit of the combination  
25 of the engine and transmission is required to reduce its own length

1 so as to secure a space utility of the passenger compartment of  
2 the vehicle.

3 To reduce the length of such a power unit, Japanese  
4 Patent Application Laid-open No. Toku-Kai-Hei 1-156134 discloses  
5 a drive train for automobile in which a longitudinally mounted  
6 engine is slanted in the widthwise direction and a final reduction  
7 gear unit or a differential separated from the transmission is  
8 disposed on the slanted side of the engine. In this case, the  
9 axle shaft penetrates the side wall of an oil pan and crankcase  
10 of the engine. Further, Japanese Patent Application Laid-open  
11 No. Toku-Kai-Hei 7-167257 discloses a technique in which the final  
12 reduction gear unit is integrated with the transmission. This  
13 type of drive train is characterized in a simple layout and a  
14 good mountability.

15 On the other hand, a multiple speed ratio transmission  
16 is required in market from the view point of vehicle performance.  
17 Particularly, in case of four wheel drive vehicles, a multiple  
18 speed ratio transmission or a dual range transmission is strongly  
19 requested. For example, Japanese Patent Application Laid-open  
20 No. Toku-Kai-Shou 55-4293 proposes a dual range type transmission  
21 having a sub-transmission between the crankshaft and the main  
22 shaft so as to change over the rotation speed of the crankshaft  
23 into two stages, Low and High, with respect to the main shaft.

24 In order to raise a productivity of transmissions, it  
25 is required that components of the transmission are shared between

1 a plurality of models or body types. For example, it is required  
2 that components common to both front wheel drive vehicles and  
3 four wheel drive vehicles are used on assembling transmissions.

4 In response to these requirements, as disclosed in  
5 Toku-Kai-Hei 1-156134, in case where the final reduction gear  
6 unit is disposed on the side of the engine, the axle shaft  
7 penetrates the side walls of the oil pan and the crankcase.  
8 Accordingly, an attempt to apply a dual transmission mechanism  
9 to this type transmission elongates the longitudinal size the  
10 transmission and as a result the layout of the drive train becomes  
11 more complicated.

12 Further, as shown in Toku-Kai-Hei 7-167257, in case  
13 where the final reduction gear unit is integrated with the  
14 transmission, the layout of the drive train is simplified, however  
15 since generally a front drive shaft is fitted to the hollow counter  
16 shaft, the length of the transmission increases. It is  
17 disadvantageous in length that a multiple speed ratio gearing  
18 mechanism or a dual range mechanism is further incorporated into  
19 the transmission.

20

## 21 SUMMARY OF THE INVENTION

22 It is an object of the present invention to provide  
23 a transmission whose drive train layout is simple, even in case  
24 where a multiple speed ratio transmission mechanism or a dual  
25 range mechanism is incorporated into the transmission. It is

1 another object of the present invention to provide a compact  
2 transmission easy to be mounted on a vehicle. It is further object  
3 of the present invention to share components among a plurality  
4 of transmission types in order to reduce manufacturing cost of  
5 the transmission.

6 To achieve these objects, the present invention  
7 comprises a main shaft connected with a crankshaft of an engine  
8 through a clutch and having a plurality of first drive gears,  
9 a counter shaft provided below and in parallel with the main shaft  
10 and having first driven gears meshing with the first drive gears  
11 and having a second drive gear, a drive shaft provided below and  
12 in parallel with the counter shaft and having a second driven  
13 gear meshing with the second drive gear, a front differential  
14 provided at a front end of the drive shaft, a transmission case  
15 for accommodating the main shaft, the counter shaft, the drive  
16 shaft and the front differential, a space formed in a front part  
17 of the transmission case, a center differential provided at a  
18 rear end of the counter shaft for distributing driving force into  
19 driving force for front wheels and driving force for rear wheels,  
20 a sub transmission accommodated in the space for transmitting  
21 driving force of the engine to the main shaft while reducing the  
22 rotation speed of the engine.

23

24 BRIEF DESCRIPTION OF DRAWINGS

25 Fig. 1 is a skeleton diagram showing an automobile

1 manual transmission according to a first embodiment of the present  
2 invention;

3 Fig. 2 is a partially sectional view showing a front  
4 portion of the transmission of Fig. 1;

5 Fig. 3 is a partially sectional view showing a rear  
6 portion of the transmission of Fig. 1;

7 Fig. 4 is a sectional view taken along an A-A line  
8 Of Fig. 2;

9 Fig. 5 is a skeleton diagram showing an automobile  
10 manual transmission according to a second embodiment of the  
11 present invention;

12 Fig. 6 is a partially sectional view showing a front  
13 portion of the transmission of Fig. 5;

14 Fig. 7 is a skeleton diagram showing an automobile  
15 manual transmission according to a third embodiment of the present  
16 invention; and

17 Fig. 8 is a partially sectional view showing a rear  
18 portion of the transmission of Fig. 7.

19

20 DETAILED DESCRIPTION OF THE INVENTION

21 Referring to Fig. 1, numeral 4 denotes a transmission  
22 case including a front transmission case 1, an intermediate  
23 transmission case 2 and a rear transmission case 3. The  
24 transmission case 4 is connected at the front end thereof with  
25 an engine 5 which is longitudinally mounted in an engine room

1 and is connected at the rear end thereof with an extension case  
2 6.

3 An input shaft 7 is rotatably supported by a bearing  
4 1b provided in a front wall 1a of the front transmission case  
5 1. The input shaft 7 is connected with a flywheel 9 which is mounted  
6 on a crankshaft 8 of the engine 5 through a clutch 10. Further,  
7 the input shaft 7 is spline-fitted to a clutch hub 10a. A main  
8 shaft 11 extends coaxially with the input shaft 7 in the  
9 longitudinal direction of a vehicle and is rotatably mounted in  
10 the transmission case 4. The main shaft 11 is rotatably fitted  
11 at a front end thereof to a rear end of the input shaft 7 and  
12 is supported by the bearing 1b through the input shaft 7. Further,  
13 the main shaft 11 is supported at a rear end thereof by a bearing  
14 3a provided in the rear transmission case 3. Furthermore, the  
15 main shaft 11 is supported at an intermediate portion thereof  
16 by a bearing 2a.

17 Further, a counter shaft 12 is rotatably mounted in  
18 the transmission case 4 in parallel with and below the main shaft  
19 11. The counter shaft 12 is supported at a front end thereof by  
20 a bearing 1c provided in the front transmission case 1 and is  
21 supported at a rear end thereof by a bearing 3b provided in the  
22 rear transmission case 3.

23 A main transmission section 13 having five forward  
24 speeds is formed by gear sets provided between the main shaft  
25 11 and the counter shaft 12 in the intermediate transmission case

1 2 and the rear transmission case 3. Further, a sub transmission  
2 14 having two ranges of speed, high and low, is formed by gear  
3 sets provided between the input shaft 7, the main shaft 11 and  
4 the counter shaft 12 in the front transmission case 1.

5 The sub transmission 14 has an input gear 15 mounted  
6 on the input shaft 7, a driven gear 16 rotatably mounted on the  
7 main shaft 11 and a counter sleeve 19 rotatably mounted on the  
8 counter shaft 12 through a needle bearing. The counter sleeve  
9 19 includes a counter gear 17 constantly meshing with the input  
10 shaft 15 and a low range gear 18 constantly meshing with the driven  
11 gear 16. There is provided a range changeover section 20 composed  
12 of a synchromesh having a sleeve 20a (see Fig. 2) and the like  
13 between the input gear 15 and the driven gear 16. When the range  
14 switching section 20 operates to engage the sleeve 20a with a  
15 spline of the input shaft 7, the input shaft 7 is connected with  
16 the main shaft 11. On the other hand, when the sleeve 20a is engaged  
17 with a spline of the driven gear 16, the rotation of the input  
18 shaft 7 is transmitted to the main shaft 11 through counter sleeve  
19 19, while the rotation speed is reduced by a gear ratio, thereby  
20 a low range is obtained.

21 Thus constituted sub transmission 14 can utilize the  
22 counter shaft 12 of the main transmission 13 as a counter shaft  
23 for the sub transmission 14 without providing a counter shaft  
24 dedicated to the sub transmission. Accordingly, a longitudinal  
25 size of the overall transmission can be saved. Further, since

1 a counter shaft dedicated to the sub transmission can be abolished,  
2 the number of parts can be reduced.

3 In the main transmission section 13, the main shaft  
4 11 is provided with a first (1<sup>st</sup>) speed gear 21, a second (2<sup>nd</sup>)  
5 speed gear 22 which rotate integrally therewith and a third (3<sup>rd</sup>)  
6 speed gear 23 and a fourth speed gear (4<sup>th</sup>) which rotate freely  
7 thereabout. Further, the main shaft 11 is provided with a reverse  
8 gear 26 which rotates integrally therewith. Further, in the front  
9 transmission case 1, a fifth (5<sup>th</sup>) speed gear 25 is rotatably  
10 mounted on the main shaft 11 adjacent to the sub transmission  
11 section 14.

12 A driven gear 21a constantly meshing with the first  
13 speed gear 21 and a driven gear 22a constantly meshing with the  
14 second speed gear 22 are rotatably mounted on the counter shaft  
15 12. Further, a driven gear 23a constantly meshing with the third  
16 speed gear 23, a driven gear 24a constantly meshing with the fourth  
17 speed gear 24 and a driven gear 25a constantly meshing with the  
18 fifth speed gear 25 are securedly mounted on the counter shaft  
19 12 to rotate integrally with the shaft 12.

20 The counter shaft 12 is provided with a synchromesh  
21 27 having a sleeve 27a and the like between the driven gears 21a  
22 and 22a. When the sleeve 27a is engaged with a spline of the driven  
23 gear 21a, the rotation of the main shaft 11 is transmitted to  
24 the counter shaft 12 through the first speed gear 21. When the  
25 sleeve 27a is engaged with a spline of the driven gear 22a, the

1 rotation of the main shaft 11 is transmitted to the counter shaft  
2 12 through the first speed gear 22.

3 The sleeve 27a of the synchromesh 27 meshes with a  
4 reverse gear 26 through a reverse idle gear (not shown).

5 The main shaft 11 is provided with a synchromesh 28  
6 having a sleeve 28a and the like between the third speed gear  
7 23 and the fourth speed gear 24. When the sleeve 28a is engaged  
8 with a spline of the third speed gear 23, the rotation of the  
9 main shaft 11 is transmitted to the counter shaft 12 through the  
10 third speed gear 23. When the sleeve 28a is engaged with a spline  
11 of the fourth speed gear 24, the rotation of the main shaft 11  
12 is transmitted to the counter shaft 12 through the fourth speed  
13 gear 24.

14 The main shaft 12 is provided with a synchromesh 29  
15 having a sleeve 29a and the like adjacent to the fifth speed gear  
16 25. When the sleeve 29a is engaged with a spline of the fifth  
17 speed gear 25, the rotation of the main shaft 11 is transmitted  
18 to the counter shaft 12.

19 Thus, since the main transmission 13 has shift stages  
20 of five forward speeds and the sub transmission 14 has two speed  
21 ranges, high and low, this transmission is a dual range transaxle  
22 type transmission having shift stages of ten forward speeds in  
23 total.

24 Referring to Fig. 3, there is provided a spline hole  
25 at the rear end of the counter shaft 12. The spline hole is engaged

1 with an input shaft 31 of a center differential 30. Accordingly,  
2 the output of the main and sub transmissions 13, 14 is inputted  
3 to the center differential 30 through the counter shaft 12. The  
4 input shaft 31 is supported by bearings 3c and 6a.

5 The center differential 30 has a pinion shaft 33 fixedly  
6 penetrating the input shaft 31 in the radial direction thereof  
7 and secured to a differential case 32. Differential pinions 34,  
8 35 are rotatably mounted on the pinion shaft 33 and mesh with  
9 differential side gears 36, 37, respectively.

10 There is provided a viscous coupling 38 between the  
11 side gear 36 and the differential case 32. The differential side  
12 gear 36 is spline-fitted over a rear drive gear 39 which is  
13 rotatably mounted on the input shaft 31 through a needle bearing.  
14 The rear drive gear 39 meshes with a driven gear 42 of a rear  
15 wheel drive shaft or a rear drive shaft 41 rotatably supported  
16 by the extension case 6 through bearings 6b, 6c. The other  
17 differential side gear 37 is spline-fitted over a front drive  
18 gear 43 which is rotatably mounted on the counter shaft 12 through  
19 a needle bearing. The front drive gear 43 meshes with a driven  
20 gear 45 of a front wheel  
21 drive shaft or a front drive shaft 44 rotatably supported by  
22 bearings 1d, 3d.

23 As shown in Fig. 2, a front differential 46 is  
24 incorporated in the front transmission case 1. The front  
25 differential 46 includes a hypoid gear 46 which meshes with a

1 hypoid pinion 48 secured to the front end of the front drive shaft  
2 44. Further, as shown in Fig. 1, the rear drive shaft 41 is  
3 connected with a rear differential 49 through a propeller shaft.  
4 Thus, the driving torque distributed by the center differential  
5 30 is transmitted to front and rear wheels through the front and  
6 rear differentials 46, 49, respectively.

7 The front transmission case 1 has a space 50a  
8 partitioned by the intermediate transmission case 2 in the upper  
9 part thererof. This space 50a provides a sub transmission chamber  
10 accommodating the sub transmission 14 and the fifth speed gear  
11 25 for high range.

12 In the lower part of the front transmission case 1, a differential  
13 chamber 50b for accommodating the front differential 46 is formed.

14 As shown in Fig. 3, the partition wall between the rear  
15 end of the rear transmission case 3 and the bearing 6c is provided  
16 with an oil pump 51, whose drive shaft is connected with the rear  
17 end of the main shaft 11. Thus, the oil pump 51 is driven by the  
18 main shaft 11. The drive shaft of the oil pump 51 has a hollow  
19 hole through which oil is discharged. The discharged oil is  
20 supplied to hollow holes provided in the center of axis of the  
21 main shaft 11 and the counter shaft 12, that is, lubrication oil  
22 passages, to lubricate components of the transmission.

23 Referring to Fig. 4, the counter shaft 12 is positioned  
24 below the main shaft 11 and its center of axis is offset by S1  
25 in an one widthwise direction of the vehicle. Further, the front

1    drive shaft 44 is offset by S2 in the other widthwise direction  
2    of the vehicle. This arrangement of the shafts 11, 12 and 44 is  
3    effective for reducing the vertical size of the transmission case  
4    4.

5           Since in thus constructed transmission the front drive  
6    shaft 44 is arranged below the counter shaft 12 differently from  
7    a type of transmission in which the front drive shaft 44 is  
8    incorporated into the counter shaft 12, the sub transmission 14  
9    can be incorporated between the main shaft 11 and the counter  
10   shaft 12 and at the same time the front differential 46 can be  
11   incorporated into the front transmission case 1 without enlarging  
12   the longitudinal size of the transmission. Further, since the  
13   longitudinal size of the transmission is reduced, an interior  
14   space of the passenger compartment can be secured and a power  
15   unit having a good mountability onto the vehicle is obtained.

16           A front wall 1a of the front transmission case 1 facing  
17   the clutch 10 is provided with bearings 1b, 1c. As shown in Fig.  
18   4, since each of the transmission case 1, the intermediate  
19   transmission case 2 and the rear transmission case 3 has a  
20   cylinder-like configuration enclosing the main shaft 11 and the  
21   like peripherally, the strength of the transmission case 4 can  
22   be increased, compared to the transmission case having a  
23   longitudinal mating surface.

24           Further, since these transmission cases 1, 2 and 3 have  
25   a drum-like configuration respectively, the transmission can be

1 assembled in an upright position and as a result the work  
2 efficiency is enhanced.

3 Next, describing a second embodiment by reference to  
4 Figs. 5 and 6, this manual transmission is applied to a four wheel  
5 drive vehicle similarly to the first embodiment but it is not  
6 provided with a sub transmission 14. In these drawings, the  
7 components identical both to the first and second embodiments  
8 are denoted by identical reference numbers. Accordingly, the  
9 transmission does not include an input gear 15, a driven gear  
10 16, a counter sleeve 19 and a range changeover section 20. Further,  
11 since the transmission has no sub transmission, the input shaft  
12 7 is replaced with a main shaft 11a. As shown in Fig. 6, a front  
13 end of the main shaft 11a is spline-fitted to a clutch hub 10a.

14 On the other hand, since this transmission has the same  
15 structure as the transmission of Fig. 3 except the components  
16 for the sub transmission including the configuration of the front  
17 transmission 1, transmission components can be shared with other  
18 types of transmission. Thus, transmissions with and without sub  
19 transmission can be assembled using common parts.

20 Fig. 7 is a skeleton diagram of an automobile manual  
21 transmission according to a third embodiment and Fig. 8 is a  
22 sectional view showing a rear part of the manual transmission.  
23 In these drawings, the components identical both to the second  
24 and third embodiments are denoted by identical reference numbers.

25 This manual transmission is applied to a front drive

1 vehicle and the construction of the transmission according to  
2 this embodiment has the same construction as a transmission  
3 portion excepting a four wheel drive mechanism of the transmission  
4 according to the second embodiment. In place of the extension  
5 case 6 of the second embodiment, a cover 52 is attached to the  
6 rear end of the transmission case 4. Further, another type of  
7 a front drive gear 43a is mounted on the counter shaft 12. Thus,  
8 a transmission dedicated to the front drive vehicle is obtained.

9 In the transmission having no sub transmission as shown  
10 in Figs. 5 and 7, by incorporating gears for 6<sup>th</sup> or more speed  
11 ratios into the space 50a, it is possible to realize a multiple  
12 speed ratio transmission with 6<sup>th</sup> or more speed ratios.

13 In the preferred embodiments described before, a  
14 manual transmission is primarily exemplified, however other  
15 types of transmission, for example, an automatic transmission  
16 may be replaced with the manual transmission. That is, the present  
17 invention may be applied also to the automatic transmission.

18 In summary, according to the present invention,  
19 components such as a transmission case, gear trains and the like  
20 can be shared among a transmission for four wheel drive vehicle  
21 with sub transmission, a transmission for four wheel drive vehicle  
22 without sub transmission and a transmission for front drive  
23 vehicle.

24 Further, since the differential is incorporated in the  
25 transmission case and left and right axle shafts for transmitting

1 driving force to left and right wheels respectively can have an  
2 identical length and therefore these axle shafts can be shared  
3 with each other.

4 While the presently preferred embodiments of the  
5 present invention have been shown and described, it is to be  
6 understood that these disclosures are for the purpose of  
7 illustration and that various changes and modifications may be  
8 made without departing from the scope of the invention as set  
9 forth in the appended claims.

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